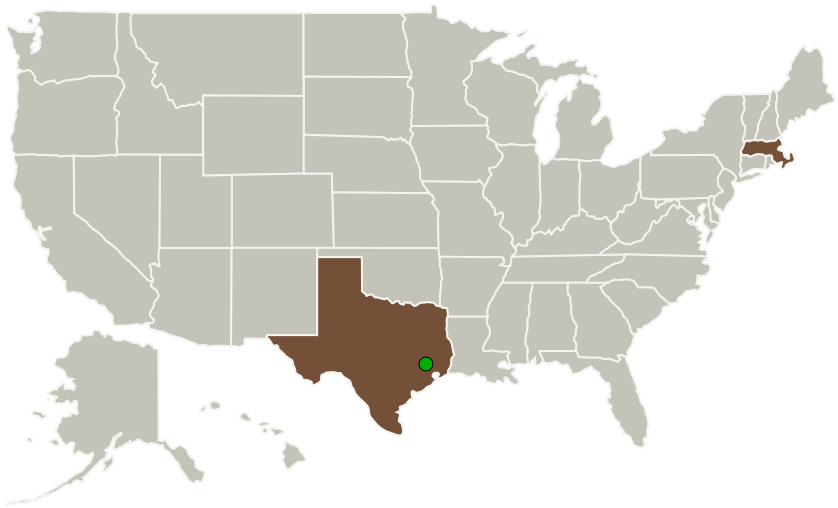
Automated Manufacture of Damage Detecting, Self-Healing Composite Cryogenic Pressure Vessels, Phase I

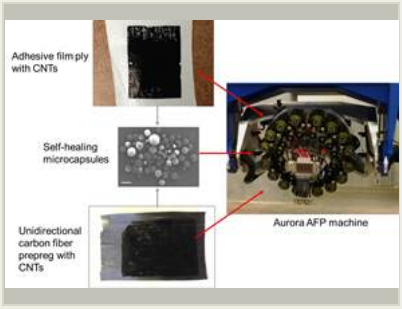
Completed Technology Project (2014 - 2014)

Project Introduction

During Phase I, Aurora Flight Sciences and the University of Massachusetts Lowell propose to demonstrate the feasibility of enhancing a commercially available out-of-autoclave (OOA) carbon prepreg material system (e.g. IM7/5320) via embedded structural health monitoring (SHM) and self-healing capabilities, which can be manufactured by an automated fiber placement (AFP) machine. This proposed "smart" material will ultimately enable the cost-effective manufacture of large, lightweight core-stiffened composite cryogenic pressure vessels. Carbon nanotubes (CNTs) will be transferred either directly onto the prepreg, or onto adhesive film plies that are subsequently laminated with the prepreg material. Electrical conductivity measurements via the CNTs will provide embedded SHM capabilities, while localized Joule heating will accelerate self-healing polymerization reactions. The CNT-enhanced prepreg will also serve as a carrier layer to embed well-dispersed self-healing micro-/nano-capsules within the polymer matrix and which will allow for self-healing of microcracks resulting from impact damage and thermal cycling. Self-healing efficiency will be characterized via mechanical testing. This smart material will ultimately be produced in spools of half-inch wide unidirectional prepreg slit tape, and laid down using Aurora's 7-axis, 16-spool automated fiber placement (AFP) machine. Trade studies will be performed on the AFP machine to determine the optimal processing parameters for laying down the smart material. The targeted demonstrator structure, a "smart" cryogenic pressure vessel, will detect microcracks caused by incident impact damage and rapidly repair the damage in situ.

Primary U.S. Work Locations and Key Partners





Automated Manufacture of Damage Detecting, Self-Healing Composite Cryogenic Pressure Vessels Project Image

Table of Contents

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Completed Technology Project (2014 - 2014)

Organizations Performing Work	Role	Type	Location
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas
University of Massachusetts-Lowell	Supporting Organization	Academia	Lowell, Massachusetts

Primary U.S. Work Locations	
Massachusetts	Texas

Project Transitions

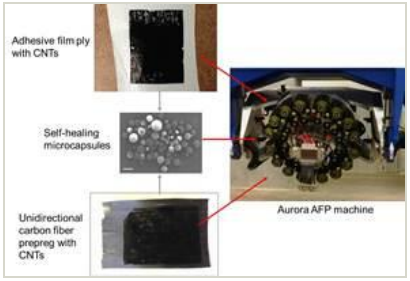
June 2014: Project Start

December 2014: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140621)*

Images



Project Image
Automated Manufacture of Damage Detecting, Self-Healing Composite Cryogenic Pressure Vessels Project Image
(https://techport.nasa.gov/image/126374)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

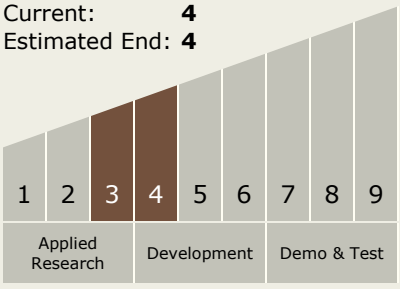
Carlos Torrez

Principal Investigator:

Konstantine Fetfatsidis

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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Completed Technology Project (2014 - 2014)

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.1 Lightweight Structural Materials

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System